Cryptosporidium: Technologies for Disinfection, Particulate Removal & By-Product Management

Presented by

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Outline of Presentation

- History/Background
- Regulations
- Treatment Technologies Available
- Treatment Technologies Limitations

History

- 1945 – Texas requires disinfection
- 1974 – SDWA promulgated
- 1979 – THM Rule
- 1986 – SDWA Amendments
- 1993 – Milwaukee *Cryptosporidiosis* outbreak
- 1996 – SDWA Amendments

Background

- Multiple Barrier Approach
  - Source Water
  - Treatment
    - Removal
    - Disinfection
  - Distribution

Regulations

- Microbiological Contamination
  - Giardia – 3-log removal/inactivation
  - Viruses – 4-log removal/inactivation
  - Cryptosporidium – 2-log removal
  - Turbidity – 0.3 NTU in 95% of samples

Regulations

- Disinfection and Disinfection By-Products
  - CT (disinfectant Concentration x contact Time)
  - Maximum Disinfectant Residual Level
  - Total Trihalomethanes
  - Haloacetic Acids
  - Chlorite
  - Bromate
  - Total Organic Carbon

Simultaneous Compliance

- Producing drinking water that meets all regulatory requirements
- ALL RULES ARE EQUAL
- One rule cannot be undermined in favor of another
- Simultaneous compliance will be challenge

Disinfection

- Chlorine
  - Liquid
  - Tablet
  - Gas
  - On-site generation
- Chloramine (chlorine + ammonia)
  - Liquid
  - Gas

Disinfection

- Ozone
- Chlorine dioxide
- Ultraviolet light

Limitations of Disinfectants

- Chlorine
  - Contact time
  - DBPs
  - Demand versus residual
  - Safety
- Chloramines
  - Weak disinfectant
  - Potential regrowth

Limitations of Disinfectants

- Ozone
  - Strong disinfectant
  - DBPs
  - No residual
  - Safety
  - Biodegradable organics affects water quality

Limitations of Disinfectants

- Chlorine Dioxide
  - Strong disinfectant
  - DBPs
  - No residual
  - Safety

Limitations of Disinfectants

- Ultraviolet light
  - Not a disinfectant
  - No residual
  - Special instrumentation
  - Special maintenance

Removal Technologies

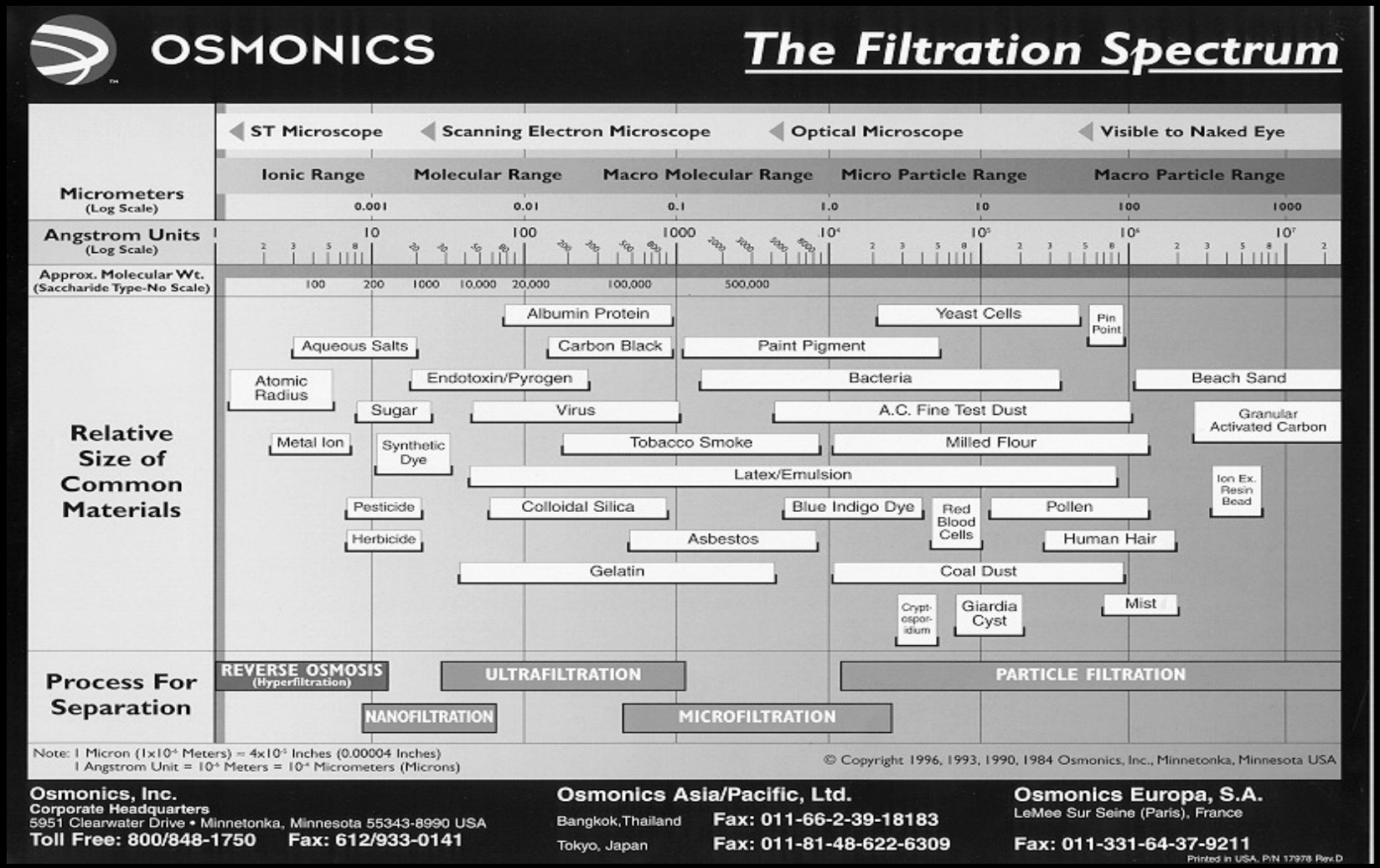
- Conventional treatment
  - Flocculation
  - Sedimentation
  - Filtration
    - Monomedia
    - Dual media
    - Mixed media

Removal Technologies

- Direct filtration
- Slow sand filtration
- Diatomaceous earth filtration
- Cartridge/Bag/Backwashable filters

Removal Technologies

- Microfiltration
- Ultrafiltration
- Nanofiltration
- Reverse osmosis


OSMONICS
The Filtration Spectrum
ST Microscope
Scanning Electron Microscope
Optical Microscope
Visible to Naked Eye
Ionic Range
Molecular Range
Macro Molecular Range
Micro Particle Range
Macro Particle Range
Micrometers (Log Scale)
0.001
0.01
0.1
1.0
10
100
1000
Angstrom Units (Log Scale)
10
100
1000
Approx. Molecular Wt. (Saccharide Type-No Scale)
100
200
1000
10,000
20,000
100,000
500,000
Relative Size of Common Materials
Albumin Protein
Yeast Cells
Pin Point
Aqueous Salts
Carbon Black
Paint Pigment
Atomic Radius
Endotoxin/Pyrogen
Bacteria
Beach Sand
Sugar
Virus
A.C. Fine Test Dust
Granular Activated Carbon
Metal Ion
Synthetic Dye
Tobacco Smoke
Milled Flour
Latex/Emulsion
Ion Ex. Resin Bead
Pesticide
Colloidal Silica
Blue Indigo Dye
Red Blood Cells
Pollen
Herbicide
Asbestos
Human Hair
Gelatin
Coal Dust
Crypt-ospor-idium
Giardia Cyst
Mist
Process For Separation
REVERSE OSMOSIS (Hyperfiltration)
ULTRAFILTRATION
PARTICLE FILTRATION
NANOFILTRATION
MICROFILTRATION
Note: 1 Micron (1x10⁻⁶ Meters) = 4x10⁻⁵ Inches (0.00004 Inches)
1 Angstrom Unit = 10⁻¹⁰ Meters = 10⁻⁴ Micrometers (Microns)
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Printed in USA, P/N 17978 Rev.D

Removal Tech. Limitations

- Conventional treatment
  - Handle wide range of water quality
  - Expensive
- Direct filtration
  - Low turbidity
  - Algae may be a problem

Removal Tech. Limitations

- Slow sand
  - Low turbidity
  - Algae may be a problem
- Direct filtration
  - Low turbidity
  - Low removal credits for Giardia/viruses
  - Algae may be a problem
  - Not allowed in Texas on surface water

Removal Tech. Limitations

- Diatomaceous earth filtration
  - Good water quality required
  - Low bacteria and viruses removal
- Cartridge/Bag/Backwashable
  - Exceptional water quality required
  - Pretreatment required
  - Variable particulate removal

Removal Tech. Limitations

- Membranes
  - High pressure requires exceptional water quality
  - Stabilization of permeate required
  - Low pressure replaces conventional treatment
  - Cost is decreasing as usage increases

DBP Control

- Move the point of disinfectant application
- Increase DBP precursor removal
- Change the disinfectant used
  - Primary
  - Secondary

DBP Control

- Temperature
- pH
- Aggressive flushing program
- Corrosion leads to elevated disinfectant residuals
- Supplemental (boost) disinfectant addition in the distribution system

Questions & Answers